13. The process of claim 12 wherein the surface features comprise grooves and/or protrusions on each wall.

14. The process of claim 1 wherein the microchannel distillation sections have heat exchange channel zones thermally communicating with the microchannel distillation sections, a heat exchange fluid flows in the heat exchange channel zones, the heat exchange fluid undergoes partial boiling in the heat exchange channel zones, the pressure of the heat exchange fluid in each of the heat exchange channel zones being different.

15. The process of claim 1 wherein the microchannel distillation sections have heat exchange channel zones thermally communicating with the microchannel distillation sections, a heat exchange fluid flows in the heat exchange channel zones, the heat exchange fluid undergoes partial boiling in the heat exchange channel zones, the temperature in each microchannel distillation section being different.

16. The process of claim 1 wherein at least part of the more volatile component rich vapor phase is condensed and withdrawn from the microchannel distillation unit.

17. The process of claim 17 wherein the more volatile component rich vapor phase is condensed in a microchannel condenser.

18. The process of claim 1 wherein at least part of the more volatile component rich vapor phase is condensed and flows into the microchannel distillation unit.

19. The process of claim 1 wherein at least part of the less volatile component rich liquid phase is withdrawn from the microchannel distillation unit.

20. The process of claim 1 wherein at least part of the less volatile component rich liquid phase is vaporized and flows into each microchannel distillation unit.

21. The process of claim 20 wherein the less volatile component rich liquid phase is vaporized in a microchannel reboiler.

22. The process of claim 1 wherein the microchannel distillation unit is in a microchannel distillation assembly comprising a plurality of microchannel distillation units, some of the microchannel distillation units being active and some of the microchannel distillation units being inactive.

23. The process of claim 1 wherein each microchannel distillation unit has a height of up to about 3 meters.

24. The process of claim 1 wherein the height of the equivalent theoretical plate ratio for each microchannel distillation unit is less than about one foot.

25. The process of claim 1 wherein the height of the equivalent theoretical plate ratio for each microchannel distillation unit is less than about one inch.

26. The process of claim 1 wherein the time for cooling the microchannel distillation unit from room temperature to about −33° C. is less than about 24 hours.

27. The process of claim 1 wherein the microchannel distillation unit has a distillate end and a bottoms end, at least one feed stream being introduced into at least one microchannel distillation section positioned between the distillate end and the bottoms end.

28. The process of claim 1 wherein the microchannel distillation sections have heat exchange channel zones thermally communicating with the microchannel distillation sections, each of the heat exchange channel zones comprising at least one heat exchange fluid loop.

29. The process of claim 28 wherein heat exchange fluid flows from one heat exchange fluid loop to another heat exchange fluid loop.

30. The process of claim 28 wherein at least two heat exchange fluid loops are nested.

31-120. (canceled)

121. A process for distilling a fluid mixture in a microchannel distillation assembly, the microchannel distillation assembly comprising at least one microchannel distillation unit, the microchannel distillation unit comprising a plurality of microchannel distillation sections, the microchannel distillation unit having a feed inlet, a distillate end, and a bottoms end, the fluid mixture comprising a more volatile component and a less volatile component, the process comprising:

flowing a vapor phase through the microchannel distillation unit towards the distillate end of the microchannel distillation unit;

flowing a liquid phase through the microchannel distillation unit towards the bottoms end of the microchannel distillation unit;

flowing the fluid mixture through the feed inlet for the microchannel distillation unit into at least one microchannel distillation section within the microchannel distillation unit, part of the more volatile component transferring from the fluid mixture to the vapor phase to form a more volatile component rich vapor phase, part of the less volatile component transferring from the fluid mixture to the liquid phase to form a less volatile component rich liquid phase;

flowing the more volatile component rich vapor phase through a plurality of the microchannel distillation sections in the microchannel distillation unit towards the distillate end of the microchannel distillation unit, the more volatile component rich vapor phase contacting the liquid phase in each microchannel distillation section and becoming enriched with the more volatile component;

flowing the less volatile component rich liquid phase through a plurality of the microchannel distillation sections in the microchannel distillation unit towards the bottoms end of each microchannel distillation unit, the less volatile component rich vapor liquid phase contacting the vapor phase in each microchannel distillation section and becoming enriched with the less volatile component.

122. The process of claim 121 wherein the microchannel distillation assembly comprises a plurality of the microchannel distillation units.

123. The process of claim 121 wherein the microchannel distillation unit comprises at least one process microchannel and at least one heat exchanger.

124. The process of claim 121 wherein the microchannel distillation unit comprises at least one process microchannel, the process microchannel comprising an open area to permit flow of the vapor phase and a wicking region to permit flow of the liquid phase.

125. The process of claim 124 wherein each microchannel distillation section comprises a liquid inlet for permitting liquid to flow into the open area from the wicking region, a liquid outlet for permitting liquid to flow out of the open area into the wicking region, an interior wall extending from the liquid inlet to the liquid outlet, and a capture structure, the liquid outlet being downstream from the liquid inlet.